# Exposure to Secondhand Smoke in hospitality settings in Ghana:

TID
Tobacco Induced Diseases

# Exposure to Secondhand Smoke in hospitality settings in Ghana: Evidence of Changes since Implementation of Smoke-Free Legislation

**Type**

Research paper

**Keywords**

observation, hospitality venues, Ghana, air quality monitoring, particualte matter

**Abstract**

Introduction
Ghana has a partial smoking ban with smoking allowed in designated smoking areas. Studies evaluating smoke-free laws are scarce in sub-Saharan Africa. Evaluation of smoke-free laws is an effective means of measuring progress towards a smoke-free society. This study assessed the level of compliance to the provisions of the current smoke-free policy using air quality measurement for fine particulate matter (PM2.5) in hospitality venues in Ghana.

Methods
This was a cross-sectional observational study conducted using a structured observational checklist complemented with air quality measurements using Dylos monitors across 152 randomly selected hospitality venues in three large cities in Ghana.

Results
Smoking was observed in a third of the venues visited. The average indoor (median) PM2.5 concentration was 14.6ug/m3 (range: 5.2-349). PM2.5 concentrations were higher in venues where smoking was observed (28.3 ug/m3) compared to venues where smoking was not observed (12.3 ug/m3) ($p<0.001$). Hospitality locations in Accra, Ghana's capital city, had the lowest compliance levels (59.5%) and poorer air quality compared to Kumasi and Tamale.

Conclusions
The study shows that while smoking and SHS exposure continues in a substantial number of hospitality venues, there is a marked improvement in PM2.5 concentrations as compared to earlier studies in Ghana. There is still a considerable way to go to increase compliance with the law. Efforts are needed to develop an action plan to build upon recent progress in providing smoke-free public spaces in Ghana.

**Explanation letter**

We have addressed all the comments raised by the three reviewers. Please find the attached letter to Editor will all the comments and their responses.

## Introduction

reviewer response letter for TID (FINAL).docx

Implementing smoke-free legislation remains a challenge in many low- and middle-income countries (LMICs). However, with 77% of all smoking-related deaths and 89% of secondhand smoke (SHS) related-deaths occurring in low-and middle-income countries (LMICs), it is clear that the burden of the tobacco epidemic has moved from high-income countries (HICs) to LMICs (1). This means that implementation of smoke-free laws in LMICs is paramount (2).. Article 8 of the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) (3) and its guidelines including other evidence-based policies such as MPOWER (the WHO's technical assistance package of evidence-based policies-for more information please see https://www.who.int/tobacco/mpower/mpower_report_six_policies_2008.pdf) (4) mandate protection from exposure to secondhand smoke (SHS). The WHO African Region also advocates that all countries be compliant with the requirements of FCTC article 8 guidelines, and that 100% smoke-free environments should become the status quo in all societies. This includes hospitality venues (such as bars, hotels, restaurants, night clubs an pubs) where workers have traditionally been exposed to the highest levels of SHS) (5). While smoke-free policies are becoming more common, more than 80% of the world's population (particularly LMICS) are not yet protected by these policies (6,7). This is the scenario in several countries in sub-Saharan Africa (SSA) where smoke-free policies either do not exist or are in the inceptive stages and studies on the magnitude of SHS-related air quality are poorly described and inadequate (7).

Ghana, being one of the first countries to ratify the WHO FCTC in 2004, passed a Tobacco Control Act in 2012 as part of their legal obligation (8). Section 58 (1) of the Tobacco Control Act prohibits smoking in "an enclosed or indoor area of a work place, or any other public place except in a designated area." This was later followed by a legislative instrument in 2016 (L.I.2247) which further reiterated smoke-free policies in furtherance to provisions in the tobacco control act and had specific guidelines for setting up designated smoking areas and display of appropriate NO SMOKING signage (9). Thus Ghana has a partial smoke free law as smoking is prohibited in enclosed or indoor area of the work place, or any other public place except in a designated smoking area (DSA), the display of adequate

"NO SMOKING" signages posted and ashtrays not displayed in a public place or workplace except in a DSA (10). Despite these binding principles, smoking prevalence among the youth (11-17 years) continues to rise (up to 7%) and close to 50% of students are unaware of the harmful effect of SHS (11). Furthermore, 1 in 10 children are exposed daily to SHS in homes (12).

Reducing the exposure to SHS is an important public health challenge that has been recognized by policymakers and regulators, and smokers' behaviour is influenced in part by their understanding of smoke-free legislation. Though the WHO recommends that all countries implement comprehensive smoke-free policies, defined as smoke-free policies with no exemptions for particular venue types or allowances for designated smoking areas, Ghana has a partial smoke-free policy that allows smoking to continue in certain types of enclosed public venues (13). Effectiveness of comprehensive smoke-free laws have been demonstrated in many countries. For example in Scotland air quality in bars and pubs was shown to have improved markedly after the introduction of comprehensive smoke-free laws (14). Similar findings have been demonstrated in England, Wales, Ireland and other HICs (15,16) .

There is limited evidence relating to the evaluation of the current smoke-free law and compliance levels in Ghana. Studies conducted in Ghana pre law (2007) indicated very high levels of SHS exposure (median $PM_{2.5}$ of 553 $ug/m^3$) in hospitality venues located in the urban cities of Ghana (17). A follow up study conducted in 2015 showed similar findings (median $PM_{2.5}$ of 439 $ug/m^3$) (18). Now, more than 5 years into Ghana's smoke-free policy, it is timely to evaluate the current policy given the rising smoking rates among young people and the use of other tobacco products (such as shisha) in addition to providing comparative data to the previous studies in Ghana (10,19). Evaluating the law is also useful to identify gaps and check compliance with existing regulations, and in the identification of areas requiring more effective enforcement. This study therefore aimed to determine the compliance to the provisions of the current smoke-free policies as identified in the Tobacco Control Act (2012) and L.I (2016) and provide objective data on SHS (by measuring fine particulate matter ($PM_{2.5}$) as a marker of SHS) in hospitality venues.

## Methods

*Study design*

This was a cross-sectional study comprising of objective measurements of airborne fine particulate matter ($PM_{2.5}$) in hospitality venues across three cities in Ghana. The measurements were complemented with covert observations of smoking related behavior, signage and compliance with local laws in each venue.

*Training*

A team comprised of the researcher and four research assistants received training on air quality monitoring using a low-cost monitor and compliance studies involving observational data collection. Training involved: how to operate a Dylos DC1700 (Dylos Inc, CA, USA) air quality monitor; how to download acquired data; and how to collect data in hospitality venues using an observation checklist protocol similar to that used in studies in similar settings over the past decade (20,21). The protocol included details on venue selection, visit duration, researcher safety, inside/outside air monitoring duration, logging data, assessment sheet instructions, and data transferring.

*Site Selection*

The study was conducted in the three largest cities in Ghana; Accra, Kumasi and Tamale (due to their large population density, diversity and high smoking prevalence). A list of 1532 hospitality venues of bars/pubs/restaurants/hotels and nightclubs in the three cities was obtained from the Ghana tourist authority. These venues were then stratified into the 3 major cities of the southern, middle and northern belts of Ghana respectively; Kumasi (457), Accra (949) and Tamale (126). Using a margin of error of 5%, confidence limit 95% and a no response rate of 87.7%, a total of 154 venues were obtained as the sample size of the study. A proportionate allocation was then done for each of the three cities to gather a convenience sample of 150 venues across the country. A random number generator (Minitab version 17) was then used to randomly select 150 venues from each city. Visits took place during peak working hours (from 16:00 to midnight) in each of the selected cities. In cases where the venue was closed or no longer in operation, the venue next on the list was visited.

*Data Collection*

A total of 154 venues were visited from the three cities. Data were collected over a 10-week period from July to September 2019 including a three-day pilot data collection in Kumasi. All data collection at the hospitality venues was done in pairs (the researcher and an assistant) on any particular day.

*Covert Observations*

Observational methods such as visual inspection of a venue (e.g., surveying rooms for the posting of "No Smoking" signs, staff/customer smoking, presence of DSAs, evidence of ashtrays and cigarette butts) and semi-subjective assessment of the presence of recent smoking through self-reported smell of smoke from the researcher are a relatively simple and inexpensive methods of assessing SHS exposure (20). These methods provide an easy tool to provide a snapshot of an environment at a specific point in time. A standardized observational checklist comprising of all the compliance indicators was adapted from similar studies was implemented across all venues to improve quality control (20). The standard indicators of compliance include observed smoking, presence of DSA's, presence of ashtrays and presence of NO SMOKING signs. Additional indicators of compliance such as presence of cigarette butts and the smell of smoke at the venues were also observed in this study. All field workers were trained on entering observation data. Covert data collection was agreed upon based on advice from experts and previous studies on air quality measurement that highlighted the delays and difficulties that an open approach to owners can present (22).

*$PM_{2.5}$ Measurements*

On entry to each establishment, the researchers purchased a beverage before proceeding to a seat or area as central as possible and away from any doors, windows or obvious potential sources of $PM_{2.5}$ such as open solid-fuel fires or kitchen areas. The researchers aimed to place the monitor on the seat or table level to ensure that sampling was as close as possible to the breathing zone and also tried to ensure that they were not within 1 meter of anyone smoking. Air sampling was carried out for a minimum of 30 minutes. This instrument uses a light scattering technique to measure the number of particles in two particle size ranges: more than 0.5 µm and more than 2.5 µm. All data presented in this article relate to particles in the size range between 0.5 µm and 2.5 µm; and were generated as mass concentrations using equations specific to SHS aerosol presented in Semple et al. (23–25). The Dylos devices were

switched on to start the logging process at the beginning of each series of visits and were left to measure and log 1-minute particle number concentrations for the duration of the sampling process. SHS assessment was conducted continuously for a period of 30 minutes inside each venue and the device left running between venues to allow $PM_{2.5}$ measurement in outdoor air to provide comparative data. A minimum of 30 minutes of outside air sampling was also undertaken each day in order to provide comparative data on outdoor $PM_{2.5}$ concentrations. Exact entry and exit time for each venue and time spent outside in ambient air were also recorded.

*Data Analysis*

Study team staff downloaded the air quality data using Dylos Logger software. The Dylos DC1700 measures and records the concentration of particles as described above. Each Dylos device had a specific calibration factor applied from a chamber experiment where measured concentrations of SHS $PM_{2.5}$ were compared to those reported from a calibrated Sidepak AM510 Personal Aerosol Monitor (TSI Inc, MN, USA) (24–26). Descriptive statistics including the geometric and arithmetic means, standard deviation, minimum, maximum and median were generated for the $PM_{2.5}$ levels across the whole dataset and then subdivided by city, venue type and size of venue using SPSS version 22. Observation data from the standardized checklist was also entered onto an excel sheet, coded and analysed by the research using SPSS version 22. The data was recorded at three time intervals (entry, +15minutes and +30 minutes) and the mean of the three values was used for the analysis. Descriptive statistics including percentages, proportions, means, standard deviation and medians were generated. The 'average compliance' to the smoke-free law was calculated by adding up the values of 'individual compliance indicators' and dividing it by the total number of indicators measured.

*Ethical Approval*

The study protocol was approved by the Ethics Committee of the University of Stirling (reference number: GUEP494) and KNUST (reference number: CHRPE/AP/441/18). Data collection was conducted covertly (observation and $PM_{2.5}$ measurements) hence informed consent was not taken, however researchers carried an official letter during field work describing the study plus evidence of ethical approval and contact details. All the places in which data collection occurred were 'public

places' and the individuals and the specific locations and individuals remain protected by anonymity and confidentiality.

## Results

*Description of venues*

As noted above, a total of 154 venues from three cities were included in the sample. However, two of the venues from Accra and Kumasi had incomplete information, thus 152 venues were included in the final analysis. Out of the 152 venues visited, 62% (n=94) were in Accra, 30% (n=45) in Kumasi and 9% (n=13) in Tamale. Around two thirds (65%, n=94) of the venues were hotels, 15% (n=22) were bars/pubs and 20% (n=29) restaurants. Most of the venues (70%, n=106) were large and permanent structures and could accommodate more than 30 people at a time.

*Compliance with smoke-free laws*

The Indicators of compliance (presence of DSA's and no-smoking signs, absence of smell of smoke, cigarette butts, ashtrays and any active smoking) was assessed in all 152 venues. NO SMOKING signs were evident in half of the venues (49.5%, n=75) with considerable variations by city; Accra (54.3%, n=51); Kumasi (35.6%, n=16) and Tamale (61.5%, n=8) and DSA's were present in less than 10% of the venues (6.6%, n=10) (Table 1). Tobacco smell was recorded in 51 venues (33.6%), and cigarette butts were found on the floor in 19 (12.5%) venues. Only one venue (a hotel in Kumasi) was found to be "fully compliant" with all the indicators of compliance measure in the study (Table 1). More than 90% of the venues visited did not have cigarette or other tobacco products displayed for sale. The total average compliance for all the venues was 63.1% with Accra being the least compliant (59.5%).

**(Insert Table 1)**

Bars and pubs were found to be the least compliant with indicators of smoke-free legislation as compared to hotels and restaurants (table 2).

**(Insert Table 2)**

1. *Subjective assessment of SHS*

The field observers also rated SHS exposure in all the venues as low or zero, medium and high during covert observations and these were converted to binary variables (as present or absent) for analysis.

Close to half of the venues in Accra had evidence of SHS exposure and bars and pubs were more likely to have SHS exposure compared to hotels and restaurants (figure1).

(Insert Figure 1)

*2. $PM_{2.5}$ Measurements*

Table 3 shows the $PM_{2.5}$ levels across the different cities, venue type and size. The Overall $PM_{2.5}$ concentration (indoors) in all 3 cities were 14.6*ug/m*$^3$ (median) [Min 5.2, Max 349, IQR 12.9]). Overall $PM_{2.5}$ (outdoors) was 12.4 *ug/m*$^3$ (median) [Min 3.8, Max 81.7, IQR 9.4]. $PM_{2.5}$ concentrations were higher in Accra as compared to Kumasi and Tamale with bars and pubs having higher indoor $PM_{2.5}$ measurements than hotels.

**(Insert Table 3)**

Table 4 shows the median and IQR $PM_{2.5}$ inside, outside and indoor-outdoor grouped by city. The median values in all three cities were below the WHO 24-hour air quality guidance for $PM_{2.5}$ (25 *ug/m*$^3$). It also shows for each city the difference between inside and outside $PM_{2.5}$ concentrations as measured on the day. Positive values indicate that indoor air $PM_{2.5}$ was higher than measured outdoors suggesting the presence of an indoor source(s) of $PM_{2.5}$ emissions.

(Insert Table 4)

Table 5 shows results of $PM_{2.5}$ concentrations in locations where smoking was observed (presence of staff/customer smoking, presence of smell of tobacco smoke, cigarette butts and ashtrays). Venues where smoking was observed had poorer air quality compared to outside and venues where smoking was not observed had air quality similar to that measured outdoors. Indoor-outdoor concentrations were higher in locations where smoking was observed (6 *ug/m*$^3$) compared to 1 *ug/m*$^3$ where smoking was not observed (P<0.001). In one-quarter of establishments where smoking was observed the indoor $PM_{2.5}$ concentration was at least 25 *μg/m*$^3$ greater than that measured outdoors in that city on the same day.

(Insert Table 5)

## Discussion

The study results demonstrate that close to 60% of the hospitality locations in the three cities were at least partially compliant with the current smoke-free legislation and had no observed smoking during our visit. Findings from other LMICs such as India (where smoking prevalence is much higher) using similar methods for assessing compliance to smoke-free laws recorded higher levels of compliance (>80%) in hospitality locations (27). This may partly be explained by the development of state- and district-level tobacco control laws alongside strong enforcement of the law in India, which may account for the higher compliance levels. In our study, smoking was observed in about a third of the venues (in areas meant to be smoke-free) and less than 1% of the hospitality locations had DSA's and about 50% of the venues had NO SMOKING signage. Interestingly, less than 10% of the venues had tobacco products for sale. Findings from our study clearly indicate that hospitality locations (particularly in Accra) are not fully compliant with current smoke-free legislation several years after the ratification of the FCTC (2004) and passage of the National Tobacco Control Act (2012).

Findings from other countries in Africa such as Kenya with a similar smoke-free policy like Ghana, indicated that smoking occurred in about 85% of hospitality locations in a recent study (28). Whereas, in Uganda (which has a comprehensive smoke-free law introduced in 2016), observed smoking was present in less than 20% of hospitality locations (29). The WHO recommends that all countries implement comprehensive smoke-free policies, defined as smoke-free policies with no exemptions for particular venue types or allowances for designated smoking areas as these do not protect against the health harms of secondhand smoke (13). Reviews in the African region strongly emphasize that the struggle in smoke-free policies in the region are mainly in the areas of implementation and enforcement in addition to other factors such as policy fatigue and limited resources (6,7). A considerable number of countries in the African region including Ghana have challenges with the enforcement of their smoke-free polices and that the law is continuously breached. Lessons could be learnt from Seychelles, a similar country in Africa, where the compliance to smoke-free laws was impressively high in bars and restaurants after only nine months of the enactment of the smoke-free law (30). Contributing factors for the situation in Seychelles included a smaller country size (thus requiring fewer resources for

implementation), high awareness and knowledge of the smoking ban among hospitality staff, training of hospitality staff on how to enforce the ban, and active enforcement of the ban by venue workers (31).

The second part of our study objectively assessed SHS exposure by measuring $PM_{2.5}$ concentrations in the hospitality locations within the three cities. Air quality measurement in resource-limited countries in the African Region are rarely carried out and can be expensive and time-consuming (6). Introduction of low-cost air quality monitors such as the Dylos DC 1700 for measurement of $PM_{2.5}$ has enhanced the quality and quantity of SHS data that is possible to collect; and provided evidence needed to strengthen smoke-free protection in low-income settings (21). In our study, $PM_{2.5}$ measurements in the three cities indicated that venues where smoking was observed had statistically higher $PM_{2.5}$ concentrations compared to those where smoking was not observed. The overall PM $_{2.5}$ concentrations (indoors) in the three cities was 14.6$ug/m^3$ (range: 5.2-348.8) with similar levels in the three cities; Accra (15.5$ug/m^3$); Kumasi (13.0$ug/m^3$) and Tamale (12.5$ug/m^3$). Differences were also observed between the different hospitality venues visited with bars/pubs and restaurants having higher indoor $PM_{2.5}$ than hotels. For this study, we used the WHO recommended 24h average limit in outdoor air quality of $PM_{2.5}$ of 25 *ug/m3* as a bench mark (33). The previous study in Ghana on SHS in 2010 indicated markedly elevated $PM_{2.5}$ (median 553 [IQR 259-1038] $ug/m^3$ in smoking venues and 16.0 [IQR 14.0-17.0] $ug/m^3$) in non-smoking venues (17). In our study, the average $PM_{2.5}$ measured in smoking venues was higher (23.8 $ug/m^3$) as compared to non-smoking venues (12.4 $ug/m)^3$ ($p<0.001$). Comparing $PM_{2.5}$ concentrations in hospitality venues in Ghana from 2010 with our results suggest that air quality has markedly improved with PM 2.5 concentrations having reduced from a median of 553 (pre law) to 14.6 *ug/m* in the current study indicating an almost 97% reduction.

Ghana has made significant progress in terms of improved air quality measurements in hospitality settings. However, public smoke-free law does not fully meet the standards to the WHO FCTC Article 8 (to which Ghana is a Party to); thus, both smokers and non-smokers continue to remain unprotected against SHS in many hospitality locations. There is no risk-free level of SHS and even brief/minimal exposure can cause immediate harm (2,32). Non-compliance with smoke-free laws among hospitality venues has also been found in other LMICs including Africa (21,31). The results and outcome of this

research serve as a basis to influence a discussion around the need to develop specific policies to protect consumers and employees of such premises and also implement enforcement measures to improve compliance.

The study's major strength is the use of a random strategy to sample hospitality venues as compared to the previous study in Ghana and several other studies elsewhere that have relied on convenience sampling thus subjecting the studies to selection bias. Also the inclusion of a large number of hospitality venues in the three largest cities in Ghana including the use of an objective and subjective assessment of SHS provides a more detailed estimation of SHS exposure in this setting. However, the study has several limitations that need to be noted when considering the study results. Firstly, $PM_{2.5}$ is not specific to SHS and may be generated by other non-smoking sources such as combustion of fuel and traffic pollution, however, our methodology sought to overcome this weakness by measuring outdoor $PM_{2.5}$ to provide comparative data and by presenting the difference between outdoor and indoor concentrations. The results of greater $PM_{2.5}$ concentrations in venues where smoking was observed validate the use of $PM_{2.5}$ as a marker and previous work has also shown high correlation between $PM_{2.5}$ and airborne nicotine in settings where smoking takes place (33). Other limitations include the study sites limited to the three large urban cities in Ghana and findings may not be representative of all hospitality venues in Ghana. Other weaknesses worth noting is the timing of the data collection that was done from 16:00 to 00:00 and the months during which the study was conducted (July-September). It may be possible that smoking behavior may differ at different times of the day, week or month. Lastly, the study is a cross-sectional design hence a causal relationship between smoke-free laws and SHS exposure cannot be implied. However, $PM_{2.5}$ is a well-established marker for SHS and highly correlates with air nicotine.

## Conclusion

To the best of our knowledge, this is the first study measuring $PM_{2.5}$ concentrations and compliance to the smoke-free law in randomly selected hospitality locations within Ghana's three largest cities. Smoking was observed in about 37% of the venues and less than one percent (1%) of venues were fully compliant with all the measured indicators of compliance. However, there is marked improvement in

air quality in these venues as compared to earlier studies. Possible reasons for this improvement might be the introduction of the Tobacco Control Act (2012) and the L.I.2247 during this period, which could have led to grater enforcement of smoke-free policies as compared to earlier studies and also decreasing smoking prevalence over the years. Fifteen years after the adoption of the WHO FCTC and more than five years after a National Tobacco Control Act, the study identified challenges for complete protection from SHS through legislation. There is still a considerable way to go to increase compliance with the SHS law in Ghana. Efforts are needed to develop an action plan to build on progress towards changing societal norms around smoking in hospitality venues and to ensure greater enforcement of existing smoke-free policy in Ghana.

Word Count: 3021

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1 **Tables**

2 Table 1. Compliance with specific indicators of smoke-free law in the three cities Ghana

| Indicator | Overall sample (n=152) | City | | | *P-value |
|---|---|---|---|---|---|
| | | Kumasi (n=45) | Accra (n=94) | Tamale (n=13) | |
| 1. Presence of No Smoking signage | 75 (49.5) | 16 (35.6) | 51 (54.3) | 8 (61.5) | 0.007 |
| 2. Presence of DSA's | 10 (6.60) | 4 (8.9) | 5 (5.3) | 1 (7.7) | 0.509 |
| 3. Absence of smell of smoke | 101 (66.4) | 39 (86.7) | 50 (53.8) | 11 (84.6) | 0.000 |
| 4. Absence of cigarette butts/ends | 133 (87.5) | 41 (91.1) | 80 (85.1) | 12 (92.3) | 0.636 |
| 5. Absence of active smoking | 125 (82.2) | 43 (95.6) | 70 (75.3) | 12 (92.3) | 0.004 |
| 6. Absence of ashtrays | 131 (86.2) | 40 (88.9) | 78 (83.0) | 13 (100) | 0.567 |
| *****Only one venue in Kumasi was fully compliant will all the indicators | | | | | |

3 *P-value based on fisher's test

4

5 Table 2: Compliance with specific indicators in hotels, bars/pubs and restaurants

| **Indicators** | **Type of Venue** | | |
|---|---|---|---|
| | **Hotels (n=101)** | **Bars/Pubs (n=22)** | **Restaurants (n=29)** |
| Presence of No Smoking signage | 55 (54.5) | 5 (22.7) | 15 (51.7) |
| Presence of DSA's | 4 (4.0) | 1 (4.5) | 5 (17.2) |
| Absence of smell of smoke | 81 (80.2) | 18 (81.8) | 13 (44.8) |
| Absence of cigarette butts/ends | 98 (97.0) | 8 (36.4) | 27 (93.1) |
| Absence of staff/customer smoking | 98 (97.0) | 8 (36.4) | 19 (65.5) |
| Absence of ashtrays | 94 (93.1) | 15 (68.2) | 22 (75.9) |
| *****Only one hotel in Kumasi was compliant with all indicators | | | |

Table 3: Indoor $PM_{2.5}$ Measurements by city, venue type and size

| | Indoor $PM_{2.5}$ *(ug/m³)* | | | |
|---|---|---|---|---|
| | Median | Minimum | Maximum | IQR |
| *1. City* | | | | |
| Accra (n=94) | 15.8 | 6.0 | 349 | 17.2 |
| Kumasi (n=45) | 13.0 | 5.2 | 51.3 | 10.7 |
| Tamale (n=13) | 12.5 | 6.5 | 23.8 | 6.5 |
| *2. Venue type* | | | | |
| Hotels (n=101) | 13.3 | 5.2 | 276 | 9.7 |
| Bars/Pubs (n=22) | 21.9 | 9.0 | 349 | 53.4 |
| Restaurants (n=29) | 22.0 | 6.5 | 335 | 19.9 |
| *3. Venue Size** | | | | |
| Small | 12.6 | 7.0 | 66.6 | 13.1 |
| Medium | 22.7 | 6.1 | 81.6 | 31.0 |
| Large | 13.9 | 5.2 | 349 | 10.7 |

*Measured by how many people can sit in this establishment: 1 – 15 = Small, 16 – 30 = Medium, More than 30 = Large

Table 4: $PM_{2.5}$ Concentrations Measured Inside and Outside Venues by City

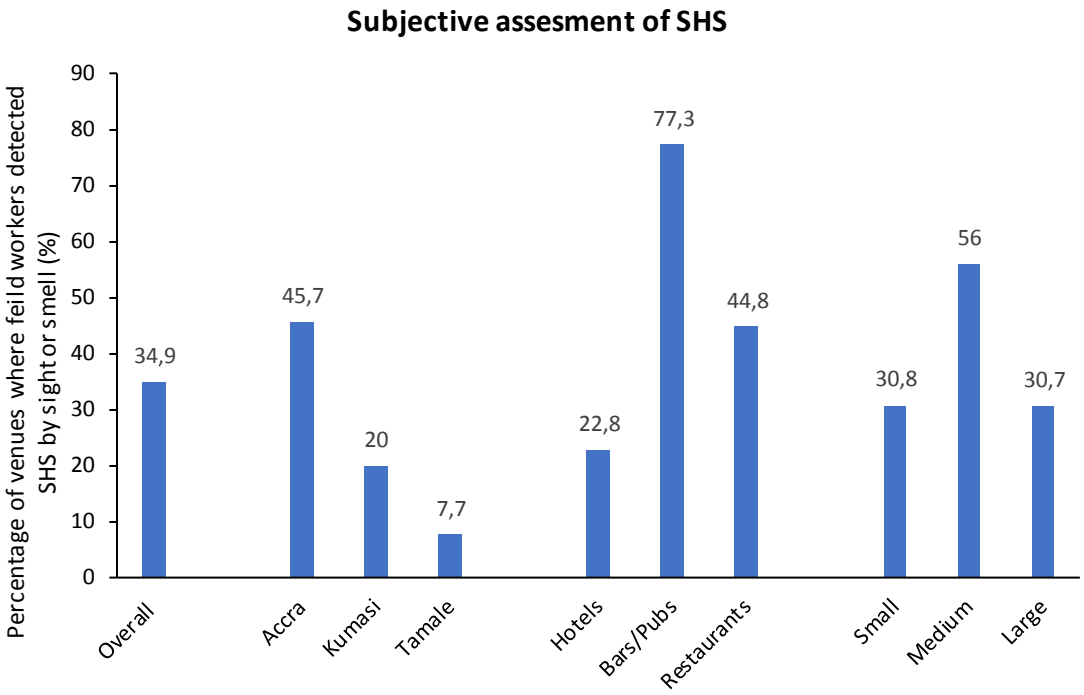
| | | **$PM_{2.5}$ Inside (ug/m3)** | | | **$PM_{2.5}$ Outdoor (ug/m³)** | | | **Indoor-outdoor $PM_{2.5}$ (ug/m3)** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | Median | 25th Percentile | 75th Percentile | Median | 25th Percentile | 75th Percentile | Median | 25th Percentile | 75th Percentile |
| **City** | | | | | | | | | | |
| **Kumasi** | 45 | 13.0 | 8.95 | 17.6 | 9.80 | 8.30 | 15.89 | 0.50 | -2.80 | 5.30 |
| **Accra** | 94 | 15.0 | 11.7 | 28.9 | 14.6 | 10.5 | 20.4 | 2.75 | -8.50 | 11.7 |
| **Tamale** | 13 | 12.5 | 7.20 | 13.7 | 5.90 | 5.70 | 11.7 | 1.70 | 1.20 | 7.70 |

Table 5: $PM_{2.5}$ measurements in smoking-observed versus smoking not observed venues

| | | **Indoor $PM_{2.5}$ *(ug/m³)*** | | | **Outdoor $PM_{2.5}$ *(ug/m³)*** | | | **Indoor-Outdoor $PM_{2.5}$ *(ug/m3)*** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Smoking observed** | Count | Median | 25th Percentile | 75th Percentile | Median | 25th Percentile | 75th Percentile | Median | 25th Percentile | 75th Percentile |
| **Yes** | 57 | 23.80 | 15.7 | 61.1 | 18.2 | 12.7 | 30.7 | 6.00 | 1.20 | 25.1 |
| **No** | 95 | 12.30 | 9.00 | 16.0 | 10.8 | 8.30 | 14.0 | 1.00 | -2.80 | 4.80 |
| ***P-value** | | P<0.001 | | | P<0.001 | | | P<0.001 | | |

*P-value based on multiple linear regression

1 **Figures**

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3 Figure 1: Subjective Assessment of SHS by Location, Venue type and Size

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